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Estimating the Economic Efficiency Consequences of Alternative Tax Reforms Using a CGE Model: Homogeneous Vs Heterogeneous Labour Specifications

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ABSTRACT

There is an increasing use of computable general equilibrium models (CGE) to measure the efficiency effects of various policy options. Often, these models use a "representative agent" to express the behavioural responses of the variety of workers, consumers and savers. In particular, they incorporate in the production function only one type of worker with a unique labour supply elasticity.

We argue in this paper that the use of a representative worker may yield misleading conclusions about the efficiency gains from some types of tax reform. For example, in the case of a shift to a single-rate tax, there is an increase in marginal tax rates for some workers and a decrease for others. The overall labour supply response, therefore, depends on the interaction between the tax change for each group and their specific labour supply elasticities.

We provide estimates of the efficiency effects of a single-rate tax using an extended multi-sector static CGE model incorporating three types of labour: low skill and low income, medium skill and middle income, high skill and high income. We simulated a very simple single-rate tax: a tax with the existing tax base, but with a single revenue-neutral rate. We estimated the efficiency effects under the "representative agent" assumption, under the assumption of three types of labour with equal labour supply elasticities, and with three types of labour each having a different labour supply elasticity.

RÉSUMÉ

Les modèles calculables d'équilibre général (MCEG) sont de plus en plus utilisés pour mesurer les effets d'efficacité économique de diverses politiques économiques. Cependant, ces modèles recourent souvent à l'hypothèse "d'agent représentatif" pour représenter le comportement des ménages en termes de consommation, d'épargne et d'offre de travail. Du côté de la demande d'emploi, il n'est considéré dans les fonctions de production sectorielles qu'un seul type de travail, donc une élasticité d'offre d'emploi unique.

Dans cet article nous montrons que les modèles qui ne considèrent qu'une seule catégorie de travail peuvent aboutir à des conclusions erronées quant aux gains d'efficacité de réformes fiscales. Ainsi en est-il d'une politique instituant un taux (marginal) unique d'impôt sur le revenu des particuliers; par rapport au système progressif actuel, une telle réforme se traduirait en effet par une hausse du taux marginal d'imposition pour certains agents et une baisse pour d'autres mais la réaction globale de l'offre d'emploi dépendra des variations relatives de taux d'imposition ainsi que des élasticités d'offres de travail spécifiques aux divers types d'agent.

Nous construisons un MCEG pour l'économie canadienne qui prend explicitement en considération trois types de facteur travail selon la qualification (haute, moyenne et élevée) en vue (i) d'estimer les effets d'efficacité économique d'une politique de taux d'imposition unique, et (ii) de les comparer à ceux obtenus avec le même modèle mais dans une version agrégée, i.e. ne considérant qu'une seule catégorie homogène de travail.

I. INTRODUCTION

The debate on tax reform has stimulated increasing interest in the use of computable general equilibrium models (CGE) to measure the distributional and efficiency effects of various policy options. Aaron and Gale (1996) review various studies that analyse different versions of flat tax proposals in the United States, using CGE models. One of these studies [Auerbach (1996)] uses a dynamic CGE model originally developed by Auerbach and Kotlikoff (1987) to evaluate the effects of a number of tax reform proposals on saving, investment and growth. Their model includes 55 overlapping generations of identical individuals by age group who maximize lifetime utility by saving and supplying labour. Fullerton and Rogers (1996) use a CGE model to estimate the lifetime effects of fundamental tax reform. Their model includes 19 industries, each of which is disaggregated into corporate and unincorporated producers, five types of capital and only one type of labour. For Canada, Beauséjour, Ruggeri and Williams (1996) evaluate the efficiency effects of some flat tax options through the use of a static multi-sector CGE model, which includes labour supply and saving responses. Their model includes 42 sectors, 43 commodities and 136 families (8 household types and 17 income classes), but only a single homogeneous labour input.

It is common to find CGE models that use a "representative agent" to express the behavioural responses of various workers, consumers and savers. Even when they include several generations and separate agents with respect to their lifetime income – as in Fullerton and Rogers (1996) – the production function incorporates only one type of worker with a unique labour supply elasticity. However, when a tax reform involves differentiated changes in marginal tax rates for different income groups, the use of a representative-agent model or a multiple-agent model with homogeneous labour elasticities may lead to misleading conclusions about the aggregate labour supply response and the associated changes in efficiency.

There are theoretical foundations for expecting declining labour supply elasticities as income increases. First, the compensated elasticities may differ by income level. For example, high-income workers on salaries may have fewer opportunities for varying working hours. Also, if they are the principal income-earners of the household, they may feel the responsibility to maintain a certain standard of living and may show little response to changes in real wages. Second, the magnitude of the income effect may increase with

earnings: for workers with low labour earnings, changes in after-tax wages do not change income very much, while they may do so for workers with high earnings. For the above reasons, one would expect variations in labour supply elasticities by income, but also by age, sex, occupation, or family status. In particular, theoretical considerations and empirical evidence suggest a pattern of labour elasticities that falls as we move from low- to high-income groups.[1] This means that the efficiency effects of tax reform do not depend only on the overall change in marginal tax rates, but on the combination of group-specific changes in marginal tax rates and the associated group-specific labour supply elasticities.

The use of the representative-agent approach in the context of different agents with different labour supply elasticities may bias the efficiency estimates of various tax policy options, and the size of the bias may differ significantly across policy options. The issue of the potential bias in efficiency effects associated with the disaggregation level adopted in a given model is not a new one. Shoven (1976) shows that the efficiency costs of a discriminatory tax on capital income in the U.S. is 40 per cent higher in a static CGE model with 12 production sectors compared with those resulting from a two-sector model of the type proposed in Haberger (1966).

In this paper, we provide estimates of the potential bias associated with the use of a representative-agent model for the evaluation of a variety of tax reform options derived from a revised version of the model presented in Beauséjour, Ruggeri and Williams (1996). In order to provide estimates of the efficiency effects of various tax reform options that incorporate different types of labour inputs, we extended the structure of the CGE model to incorporate three types of labour: low-skilled and low-income, medium-skilled and medium-income, high-skilled and high-income. We show that for some policy options – such as a move to a single-rate personal income tax – the bias from using a representative worker approach may be substantial.

II. Description of the Model

This section describes briefly the main characteristics of the static CGE model used in our simulations. This model contains sufficient functional and computational flexibility as well as institutional details to allow the evaluation of a variety of tax policy issues. The

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[1] For a review of the empirical evidence, see for example Killingsworth (1983), Killingsworth and Heckman (1986), Phipps (1993).

first section briefly presents the basic general structure of the model, while the next one describes the calibration procedure.

A. General Structure of the CGE Model

The general structure of the present version of the model (as summarized in Figure 1) is in line with most of the static models described in the CGE literature [Dervis et al. (1982), Ballard et al. (1985), and Robinson (1989)]. It is a *generic* representation, based on nested technologies, of the main characteristics of Canada as a small open economy. As can be seen from Figure 1, three interrelated blocs compose this representation: the production and supply bloc at the upper end, the demand bloc at the lower end and, finally, the equilibrium conditions that must always be satisfied.

Production and Supply

The supply side is composed of 42 domestic producing industries plus an importing external sector that provides 43 commodities, one of which is non-competitive. The production of each domestic sector [out(sect)] is represented by a nested Cobb-Douglas technology [CD] that combines two primary factors, i.e., capital and labour, and intermediate inputs.

The factor capital is itself a composite aggregate [fact(sect, capital)] of 62 homogeneous classes of assets [cap(sect, asset)] using a Leontief technology [LTF]. The distinction between these classes reflects the differences in economic depreciation rates across assets and differences in the corporate tax treatment. The composite capital is perfectly mobile across sectors and receives a single rate of return. Inter-asset substitution is not allowed, and capital is internationally mobile and owned by domestic agents and foreigners. Any aggregate discrepancy between the existing and the desired stock of capital is only satisfied by inflows or outflows of capital services. In this context, Canada is considered to be a small open economy facing a perfectly elastic supply of capital [kimp(sect)] to an exogenously given world interest rate.

The production process also uses labour [fact(sect, labour)] as primary factor. In one version of the model, only one homogeneous category of labour is available. In order to take account of differentiated labour supply responses to various tax shocks, and to estimate the possible aggregation bias of the representative agent models, a second version of the model considers, directly within the production functions, three homogeneous types

of labour with respect to their respective skills and remuneration rates. Based on the assumption that skill and remuneration are, on average, closely correlated, we assume that low (L_l), medium (L_m) and high (L_h) skill categories correspond to three classes of annual income.[2]

The last argument in the first nest represents the sectoral intermediate consumption [inter(sect)]. It is specified as a Cobb-Douglas aggregation of 43 commodities, each of which is itself a composite of a domestic and an imported competitive good.[3] In this scheme, the optimal mix of primary factors and intermediate goods demanded by each producer stems from a profit-maximizing behaviour, taking as given their respective relative prices, and targeting the production level demanded by the corresponding selling market. This decision process is influenced by various tax instruments represented in the production side of the model by: *i)* the marginal tax rate specifying the corporate income taxation [metr(sect, asset)]; *ii)* the payroll tax rates on labour [pyrl(sect, labour)]; *iii)* the commodity tax rates on intermediate materials [taxio(comm, sect)] and, *iv)* the tax rates on output [outax(sect)].

The commodity produced by each firm in every sector [out(sect)] can be offered either on the domestic market [dom(comm)] or on the international market [exp(comm, fctry)] to three foreign regions (i.e., the United States, the European community and the rest of the world.)[4] We assume that there is no trade-off for the producer to supply on one market or another. The linear technology [LIN], therefore, is adopted to reflect this perfect substitutability between the two markets. The small open economy assumption with respect to exports, when designed in the strict and usual manner, does not allow for the existence of two-way trade and would imply that Canada can export whatever quantity it wants. As a remedy, we represent foreign demand for each Canadian product by an isoelastic decreasing function with respect to the Canadian producer price relative to the

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[2] These classes are assumed to correspond to the thresholds of the three tax brackets of the federal personal income tax system.

[3] The forty-third commodity accounts for non-competitive imports to the 42 domestically produced commodities.

[4] with the exception of the housing industry

corresponding world price, while maintaining the assumption of exogenous world prices.[5] This means that Canada is represented as an *almost small open economy*. The variation of this relative price of exports and the degree of competitiveness of Canadian products on world markets are determined by the domestic cost structure of production in terms of input productivity, as well as by the fiscal configuration applied to the production process.

The supply side of the model is completed by combining the portion of each output offered on the domestic market [dom(comm)] with an imported good [imp(comm, fctry)] to form, via a constant-elasticity-of-substitution (CES) technology, a composite commodity [arm(comm)] that represents domestic users' demand for goods. This so-called Armington assumption (with the import price-taking behaviour implied by our small open economy assumption[6]) prevents both extreme and indeterminate import levels, by allowing agents to differentiate among products on the basis of their country of origin. Moreover, while this assumption does not explain the source of the observed two-way trade in the majority of commodities, it allows at least a partial justification and represents a useful approximation to more sophisticated intra-industry trade models, which are based on scale economies and within-industry variations in product characteristics.[7]

Demand and Equilibrium

As shown in Figure 1, domestic demand for the composite commodities [arm(comm)] comes from three types of agents: producers, consumers and an investor agent. Since we already discussed the intermediate demand by the producing sectors, we will concentrate here on the remaining portion demanded for final use by the consumers and the investor agent.

Consumers are disaggregated into 160 classes of individuals [ind] according to their socio-economic status. Each individual is a utility-maximizer that directly owns capital and supplies labour in order to purchase consumption goods and a savings commodity. The consumer's utility maximization [welf(ind)] corresponds to a multi-stage budgeting

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[5] Each of these prices represents an average of the prices of all the exporting countries of a given good on the world market.

[6] i.e., a perfectly elastic supply of import

[7] See Krugman (1980).

decision. At the top stage, the individual allocates its total disposable income between present consumption [tpc(ind)] and future consumption or saving [saving(ind)] following a CES utility function. Since saving is an approximation of the present value of future consumption, the utility function captures – via the elasticity of substitution parameter – the effects of intertemporal substitution between present and future consumption. At the second stage, the trade-off between total consumption of goods [cg(ind)] and consumption of leisure [leisure(ind)] is captured by a Stone-Geary [LES] technology.[8] This specification provides the needed flexibility to set both the wage and income supply elasticities of labour. Moreover, with this function, each individual's time endowment is not set arbitrarily, but is, instead, a calibrated parameter.[9] At a third and final stage, a Cobb-Douglas function is used to determine the consumption of each composite good [C(comm, ind)]. The final consumption decisions involved in this final stage are influenced by the consumption tax structure, which is explicitly taken into account [taxcom] in the model.[10]

The agents' decisions are affected by the personal income tax system in two ways. First, the personal income tax influences the choice between labour supply and consumption of leisure through the real after-tax wage rate. Second, the real after-tax rate of return to savings influences the choice between future and current consumption. This intertemporal decision is captured by including savings in the utility function (since savings approximate the present value of future consumption). In order to take account of the progressivity of federal and provincial income tax rates, we assume that personal income taxes are imposed at an ad-valorem rate equal to each individual's effective marginal tax rate.[11] A virtual transfer is then given back to the individual to provide compensation for the fact that not all income is taxed at the marginal rate. Changing the

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[8] This approach was used in Ballard et al. (1985).

[9] For a similar treatment, see Fortin et al. (1993).

[10] The decisions concerning investment as well as intermediate consumptions are also influenced by the tax structure.

[11] In the benchmark case, the combined federal-provincial marginal tax rates are calculated by multiplying federal basic rates by 1.55 (implying that on average basic provincial rates are 55 per cent of the corresponding federal rates), and adding federal and provincial surtaxes.

progressivity of the rate structure involves, therefore, changes in the marginal tax rates and in the magnitude of the virtual transfer.

Note that the model does not allow for a taxpayer to move from one tax bracket to another. This restriction may affect the comparisons between representative-agent and multi-agent models, because it may affect the results for the latter, but not for the former. Given the magnitude of the shocks simulated, this restriction, however, is not expected to affect the comparisons shown in this paper.

Finally, for the investor agent, the problem is simple since it only needs to determine the level of aggregate investment [invg ("inv")] as well as its composition [C(comm, ind)]. While optimal composition is determined via a Cobb-Douglas functional form, the aggregate level of investment must always satisfy the macroeconomic material balance condition (i.e., that investment must equal the sum of domestic saving, depreciation and foreign saving). Since the current account must be balanced (i.e., since the net value of service payments for capital inflows/outflows must equal the balance of trade), aggregate investment actually equals the sum of domestic saving and depreciation.

B. Empirical implementation of the model

Industry output and intermediate input demands are calibrated using the 1992 input-output tables. Data are made consistent with the 42-sector structure of the CGE model. Asset class shares, which allow for the disaggregation of industry capital service payment, are calculated as averages over the 1990-92 data from Revenue Canada's T2 form. The 1992 input-output database is also used to allocate final demand between consumption and investment.

Using the input-output database ensures equilibrium for all good markets, and guarantees that all income is spent. By assuming that the 1992 observed data represent a long-term equilibrium, we imply that supply and demand of primary factors of production are in equilibrium and, consequently, that net payment for (receipt from) foreign capital equals the net trade balance.

The data used to distribute consumption, saving and gross income between the 8 family types and the 20 income groups come from the Socio-Policy Simulation Database

and Model (SPSD/M) developed by Statistics Canada.[12] SPSD/M was used to calculate, for each type of household, its weight in the Canadian population, labour income, investment income (including interest, dividends and capital gains), savings, total federal and provincial personal income tax paid, disposable income, federal and provincial personal income marginal tax rate, non-refundable credit as well as claimed deduction. These values are made consistent with the input-output database and the national accounts for personal income tax.

The remaining data involve the parameters needed to calibrate the production and utility functions. For Cobb-Douglas and Leontief functions, we do not need any additional parameters to complete the calibration of the nest. Canadian import price elasticities are obtained from Létourneau and Lester (1988). Canadian export price elasticities are derived from estimates of United States import price elasticities in Almon et al. (1975). The most relevant elasticities for our experiments were chosen to be in the middle of recent estimates. The elasticity of substitution between current consumption and saving is set at 0.2 (see Randolph and Rogers (1996)). For the "representative agent" version of the model, the uncompensated wage elasticity was fixed at 0.1, which is consistent with the value used by Ballard et al. (1985), and the labour supply income effect was set at 0.2 for each person.[13] For the multi-agent version (identified as *Case 1*), we raised the uncompensated elasticity to 0.2 for low-skilled workers, kept it at 0.1 for medium-skilled workers and lowered it to 0.05 for high-skilled workers. The income effect was reduced to 0.17 for all workers in order to maintain an aggregate labour supply elasticity of the same magnitude as the one used in the "representative agent" version. In addition to these base case values, we performed a sensitivity test by taking a narrower differential in labour supply elasticities (identified as *Case 2*).

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[12] The family types are: single, single with kids, one income couple, one income couple with kids, two income couple, two income couple with kids, single over 65 and couple over 65.

[13] The labour supply income effect is also known in the literature as the *marginal propensity to earn out of nonwage income*.

III. Simulations and Results

A. Simulated Options

Single-Rate Personal Income Tax

The first simulation involves the replacement of the current multi-rate structure of the personal income tax (PIT) with a single revenue-neutral rate. In the simulations, the multi-rate schedule is replaced by a single revenue-neutral rate of 32.7 per cent and there are no changes in the tax base. The tax value of non-refundable tax credits is constant, which implies that both the credit amount and the applicable tax rate were kept unchanged.

At 32.7 per cent, the single tax rate involves a higher marginal tax rate for taxpayers in the first tax bracket, a moderately lower rate for those in the second bracket and an even lower one (in relative terms) for those in the top bracket. The compression of the rate structure implies that taxpayers in the first tax bracket will experience a higher tax burden while the rest, especially those with very large incomes, will have a lower tax burden.[14] The CGE model captures the interactions between the substitution and income effects for each category of workers.

Table 1 presents the results of our first set of simulations. Under the "representative agent" approach, the compression of the personal income tax rate structure into a single rate would raise labour supply, real GDP and welfare by, respectively, 1.52, 1.36 and 0.21 per cent. The results differ substantially under the assumption of the existence of three types of workers: labour supply, real GDP and welfare increase by, respectively, 0.85, 0.74 and 0.09 per cent. Compared to the three-agent approach in *Case 1*, the "representative agent" model overstates the increase in real GDP by 84 per cent, the increase in the labour supply by 79 per cent and the welfare gain by 133 per cent.

The intuition behind the results is as follows: the use of a "representative agent" model (or model with homogeneous labour supply elasticities) overstates the efficiency gains resulting from a move to a flat tax because it ignores the offsetting effects that take place in a model where different types of labour, with different elasticities of supply, face different changes in their marginal tax rates. The move to a flat tax represents welfare gains for

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[14] This change in the rate structure is not compensated by changes in tax credits since the tax value of non-refundable tax credits is constant.

higher income workers (who see their marginal tax rate decrease) that are offset by welfare losses for lower income workers (who face an increase in their marginal tax rate). Our results show that the efficiency effects of tax reform do not depend only on the overall change in marginal tax rates, but on the combination of group-specific changes in marginal tax rates, and the associated group-specific labour supply elasticities.

In order to have some idea of the responsiveness of the economic effect indicators to differentials in labour supply elasticities, we performed a simulation where these differentials were reduced approximately by one-half compared to those in *Case 1*. As expected, the bias of the representative model is reduced, but remains quite high. The percentage changes in the labour supply and real GDP are overestimated by about 40 per cent, and the welfare gain by 75 per cent. Results in Table 1 suggest that estimates of the economic effects of flattening the rate structure are very sensitive to these differentials. Even when the labour supply elasticity of low-income workers is moderately lower than that of high-income taxpayers, representative agent models will generate over-estimations of efficiency gains.

Across the Board Reductions in PIT Rates

In this simulation, we reduced the marginal PIT rates by 5 percentage points and offset the revenue loss by a lump-sum reduction in non-taxable transfer payments. (In fact, the marginal tax rate schedule is shifted down in a parallel manner.) As Table 2 shows, in this case the potential bias of the "representative agent" is fairly small. In *Case 1*, the percentage changes in real GDP and the labour supply are overestimated by only 6 per cent and the welfare gain by 19 per cent. In *Case 2*, there are no differences in the estimates of the percentage changes in real GDP and the labour supply between "representative agent" and multi-agent models, while the welfare gains are overestimated by 12 per cent. Since, in this simulation, all agents experience the same tax change (i.e., a reduction in their tax rate), the weighted average of their responses is not much different from the implicit weighted average incorporated in the "representative agent". There are, in this case, no offsetting effects as described under the first set of simulations.

Expansion of the PIT Base

For purposes of illustration, we conducted two additional experiments that involve an expansion of the tax base combined with changes in the rate schedule. In the first simulation, we broadened the base of the personal income tax by eliminating all

deductions, and replaced the current multi-rate structure with a single tax rate. The expansion of the base allows for a substantial decrease in the revenue-neutral flat rate, from 32.7 to 29.3 per cent. As Table 3 shows, in this case, the "representative agent" model overestimates the increase in labour supply and real GDP by 30 per cent and overestimates the increase in efficiency by 42 per cent. As is with the other policy options considered, a reduction in the elasticity differentials between high- and low-skilled workers lowers the potential bias of "representative agent" models.

In the second option, we eliminated all deductions and reduced all rates of the original progressive structure to ensure revenue-neutrality. As Table 4 shows, this tax policy change yields a potential "representative agent" bias that is slightly lower than that under the base expansion combined with a flat rate. The potential bias for the increase in labour supply and real GDP falls from 30 to, respectively, 22 and 23 per cent, and from 42 to 39 per cent for efficiency.

B. Comparison of Representative Agent Bias Among Options

Table 5 presents a summary of the potential bias associated with the use of "representative agent" models in the policy options evaluated in this paper. To simplify the presentation we only show the bias with respect to labour supply and efficiency, and only under *Case 1*. Two major conclusions arise.

First, when measured in absolute terms, the potential bias in the "representative agent" model is higher for rotations in the rate schedule, as in the move from a multi-rate structure to a single rate, than for a parallel shift in the rate structure. This differentiation is more evident for welfare effects than for labour supply effects.

Second, the potential bias of the "representative agent" model, as a percentage of the changes estimated under the multi-agent model, can be quite large. Comparing the rate-compression options with the across the board rate reductions shows that the "representative agent" approach can be safely used for parallel shifts in the rate structure of a given tax, even when labour supply elasticities differ across types of workers. It will generate, however, biased results for non-parallel shifts in the rate structure, with potentially large errors in the shift from a progressive to a flat rate structure. The results also suggest that, in the presence of differential labour supply elasticities, "representative agent" models are not suitable for comparing the efficiency effects of flat taxes with those

of across the board tax reductions, because of the relatively large difference in the potential bias with respect to the two policy options.

IV. Conclusion

In this paper, we estimated the labour supply, output and efficiency effects of various tax policy changes using a highly disaggregated static CGE model that incorporates either a representative worker or three types of labour differentiated by skill level and labour supply elasticities. We show that economic effects of tax changes are larger under the "representative agent" model compared to those under the multi-agent model. The magnitude of these overestimates is larger for rotations of the rate structure than for parallel shifts. Moreover, the sensitivity analysis suggests that the differences between "representative agent" and multi-agent models may be very responsive to differences in labour supply elasticities among different types of labour. These results imply that "representative agent" models may be less appropriate for analyzing the economic effects of shifting to a flat tax, than for the analysis of an overall rate reduction.

Figure 1: CGE Model Structure

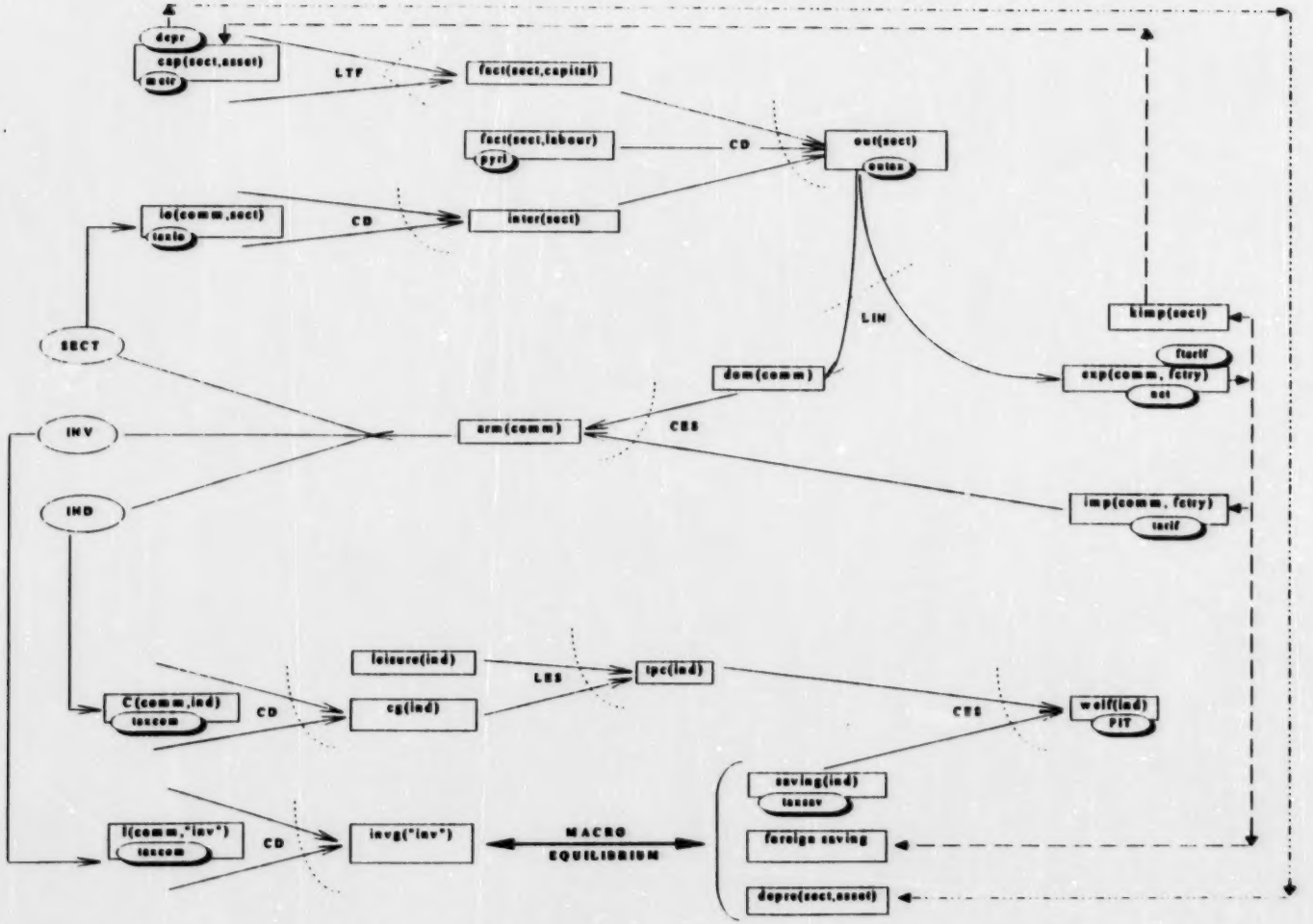

TABLE 1

ECONOMIC EFFECTS OF A SINGLE-RATE TAX: REPRESENTATIVE AGENT *VS* MULTI-AGENT MODELS, 1992 (PERCENTAGE CHANGE)

	Representative Agent	Multi-Agent Case 1			Multi-Agent Case 2		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	% Δ	% Δ	Diff. (1) - (2)	Ratio (1)/(2)	% Δ	Diff. (1) - (5)	Ratio (1)/(5)
Labour Supply	1.52	0.85	0.67	1.79	1.08	0.44	1.41
Real GDP	1.36	0.74	0.62	1.84	0.95	0.41	1.43
Utility	0.21	0.09	0.12	2.33	0.12	0.09	1.75

TABLE 2

ECONOMIC EFFECTS OF A REDUCTION OF 5 PERCENTAGE POINTS IN PIT RATES: REPRESENTATIVE AGENT *VS* MULTI-AGENT MODELS, 1992 (PERCENTAGE CHANGE)

	Representative Agent	Multi-Agent Case 1			Multi-Agent Case 2		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	% Δ	% Δ	Diff. (1) - (2)	Ratio (1)/(2)	% Δ	Diff. (1) - (5)	Ratio (1)/(5)
Labour Supply	2.23	2.11	0.13	1.06	2.24	-0.01	0.99
Real GDP	2.01	1.90	0.40	1.06	2.02	-0.01	0.99
Utility	0.37	0.31	0.06	1.19	0.33	0.04	1.12

TABLE 3

ECONOMIC EFFECTS OF A BASE EXPANSION WITH A SINGLE-RATE TAX: REPRESENTATIVE AGENT *VS* MULTI-AGENT MODELS, 1992 (PERCENTAGE CHANGE)

	Representative Agent	Multi-Agent Case 1			Multi-Agent Case 2		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	% Δ	% Δ	Diff. (1) - (2)	Ratio (1)/(2)	% Δ	Diff. (1) - (5)	Ratio (1)/(5)
Labour Supply	2.97	2.29	0.68	1.30	2.70	1.10	1.10
Real GDP	2.68	2.06	0.62	1.30	2.42	0.26	1.11
Utility	0.47	0.33	0.14	1.42	0.38	0.09	1.24

TABLE 4

ECONOMIC EFFECTS OF A BASE EXPANSION WITH EQUAL PERCENTAGE REDUCTION IN RATES: REPRESENTATIVE AGENT *VS* MULTI-AGENT MODELS, 1992 (PERCENTAGE CHANGE)

	Representative Agent	Multi-Agent Case 1			Multi-Agent Case 2		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	% Δ	% Δ	Diff. (1) - (2)	Ratio (1)/(2)	% Δ	Diff. (1) - (5)	Ratio (1)/(5)
Labour Supply	1.57	1.28	0.29	1.23	1.44	0.13	1.09
Real GDP	1.43	1.17	0.26	1.22	1.32	0.11	1.08
Utility	0.32	0.23	0.09	1.39	0.26	0.06	1.23

TABLE 5

SUMMARY COMPARISON OF EFFECTS ON LABOUR SUPPLY AND EFFICIENCY UNDER VARIOUS TAX REFORM OPTIONS: REPRESENTATIVE AGENT *VS* MULTI-AGENT MODELS, CASE 1 (1992)

Shift from current PIT to:	Labour Supply Effects		Efficiency Effects	
	Difference	Ratio[1]	Difference	Ratio[1]
1. Single-Rate PIT	0.67	1.79	0.12	2.33
2. 5 % Points Reduction in PIT Rates	0.69	1.44	0.06	1.19
3. Single-Rate / Broader Base PIT	0.68	1.30	0.14	1.42
4. Multi-Rate / Broader Base PIT with Reduction in Rates	0.29	1.23	0.09	1.39

[1] The effects are measured as the percentage change in labour supply and efficiency relative to the multi-agent case.

References

Aaron, H.J. and W.G. Gale (1996), Economic Effects of Fundamental Tax Reforms, Brookings Institution Press, Washington, D.C.

Almon, C., M. Buckler, L. Horowitz and T.C. Reimbold (1975), 1985 : Interindustry Forecasts of the American Economy, Lexington Books, Toronto.

Auerbach, A.J. (1996), «Tax Reform, Capital Allocation, Efficiency and Growth», pp. 29-81 in H.J. Aaron and W.G. Gale, eds., Economic Effects of Fundamental Tax Reforms, Brookings Institution Press, Washington, D.C.

Auerbach A.J. and L.J. Kotlikoff (1987), Dynamic Fiscal Policy, Cambridge University Press, New York.

Ballard, C.L. , D. Fullerton, J.B. Shoven and J. Whalley (1985), A General Equilibrium Model for Tax Policy Evaluation, The University of Chicago Press, Chicago.

Beauséjour, L., G.C. Ruggeri and B. Williams (1996), «Efficiency and Distributional Effects of Flat Tax Proposals», Department of Finance, Paper presented at the Canadian Economics Association Conference, Brock University, Ontario.

Dervis, K., J. deMelo and S. Robinson (1982), General Equilibrium Models for Development Policy, Cambridge University Press, Cambridge.

Fortin, B., M. Truchon and L. Beauséjour (1993), «On Reforming the Welfare System: Workfare Meets the Negative Income Tax», Journal of Public Economics, Vol. 51, no 2, pp.119-151.

Fullerton, D. and D.L. Rogers (1996), «Lifetime Effects of Fundamental Tax Reform», pp. 281-320 in H.J. Aaron and W.G. Gale, eds., Economic Effects of Fundamental Tax Reforms, Brookings Institution Press, Washington, D.C.

Harberger, A. (1966), «Efficiency Effects of Taxes on Income from Capital» pp. 281-320 in M. Krzyzaniak, ed., Effects of Corporate Income Tax, Wayne State University Press, Detroit.

Hoynes, H. (1996), «Comment», pp. 271-275 in H.J. Aaron and W.G. Gale, eds., Economic Effects of Fundamental Tax Reforms, Brookings Institution Press, Washington, D.C.

Killingsworth, M. (1983), Labour Supply, Cambridge University Press, New York.

Killingsworth, M. and J. Heckman (1986), «Female Labour Supply: A Survey», pp.103-204 in O. Ashenfelter and R. Layard, eds., Handbook of Labour Economics, Vol. 1, North-Holland, Amsterdam.

Krugman, P.R. (1980), «Scale Economies, Product Differentiation and the Pattern of Trade», American Economic Review, Vol. 70, no. 5, pp. 950-959.

Létourneau R. and J. Lester (1988), «Econometric Estimates of Import Price Elasticities for Canada», Department of Finance, Working Paper no. 88-5, Ottawa.

Pencavel, J. (1986), «Labour Supply of Men: A Survey», pp. 3-102 in O. Ashenfelter and R. Layard, eds., Handbook of Labour Economics, Vol. 1, North-Holland, Amsterdam.

Phipps, S.A. (1993), «Does Unemployment Insurance Increase Unemployment?», Canadian Business Economics, Vol. 1, no. 3, pp. 37-50.

Randolph, W.C. and D.L. Rogers (1996), «The Implications for Tax Policy of Uncertainty about Labour Supply and Saving Responses», National Tax Journal, Vol. 48, no. 3, pp. 429-446.

Robinson, S. (1989), «Multisectoral Models», pp. 899-947 in H. Chenery and T.N. Srinivasan, eds., Handbook of Development Economics, Vol. 2, North Holland, Amsterdam.

Shoven, J.B. (1976), «The Incidence and Efficiency Effects of Tax on Income from Capital», Journal of Political Economy, Vol. 84, no. 6, pp. 1261-1292.